Panel 1: Renewable Energy Forecasting Research Opportunities and Solutions to Support Modern Grid – Load Forecasting Perspective

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PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Challenge 1. Growing Disconnect between Measured Load and "True Load"

- Load forecast models are built on Measured Load. Unfortunately there is a growing disconnect between Measured Load and "True Load" which represents the demand for electricity services regardless of how it is sourced.
  - True Load >= Measured Load
- Driving factors are deeper penetration of unmeasured and volatile:
  - Behind-the-Meter Generation
  - Behind-the-Meter Storage
  - Response to Time-of-Use Rate Structures
  - Demand Response Activity
- As a result, the load forecast models are no longer models of demand for power, but rather models of demand for power after a bunch of non-measured activities are subtracted out. This would be fine if the items being subtracted were stable and predictable. That is not the case.
- Measured/Unmeasured is from the perspective of a System Operator. Most System Operators do not have a data feed on Behind-the-Meter activity.

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Challenge 2. The Relationship between Measured Load and Weather is Becoming Cloudy

» With deep penetration of Behind-the-Meter Solar Generation it is no longer sufficient to model the weather sensitive portion of Measured Load as a function of temperature and humidity. Now levels of solar irradiance need to be factored in.

» Further, the *perceived* impact of behind-the-meter solar generation is different between morning and afternoon hours. Afternoon loads appear to not dip as much as morning loads.

- One possibility is an investment in Solar PV changes how a customer utilizes their air conditioning. The argument is that after installing Solar PV customers are more likely to keep their air conditioning running to make use of the “free” electricity. This type of behavioral change would be more noticeable in the afternoon hours when air conditioning loads are highest. As a result, the higher air conditioning loads offset Behind-the-Meter Solar Generation. With little to no air conditioning loads in the morning hours the impact of Behind-the-Meter Solar Generation would be more noticeable.

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Challenge 3. Increased Load Forecast Errors and Error Volatility

» The collective impact of Challenge 1 & 2 is an increase in the average Load Forecast Error (i.e. bigger Forecast MAPEs) and an increased in average Load Forecast Error Variances.

» Traditional load forecast models that do not include explicit treatment of Behind-the-Meter Solar Generation no longer adequately capture weather-driven load swings.

» But that is just step one. Load forecast models need to account for the impact of the other big ticket items: Behind-the-Meter Storage, TOU rates, EV Charging, and Demand Response activity.

- A key research topic is developing/defining the best modeling approach for incorporating the impact of all these big ticket items into a load forecast. *The trick is how to do this with little to no data?*

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Challenge 4. Constructing Load Forecast Confidence Bounds

» The increased Load Forecast Errors are driving a call for producing Load Forecast Confidence Bounds that account for:

- Load Forecast Model Uncertainty
- Measured Load Uncertainty
- Weather Forecast Uncertainty
- BTM Solar Generation Forecast Uncertainty
- BTM Storage Activity Forecast Uncertainty
- EV Charging Forecast Uncertainty
- TOU Price Impact Uncertainty
- Demand Response Uncertainty
- Other TBD

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Challenge 5. Constructing Net Load Forecast Confidence Bounds

» There is a growing need to reconcile or at least make consistent the Load Forecast Uncertainty with the forecast uncertainty associated with Utility-Scale Wind and Solar Generation Forecasts.

- How do you develop Net Load Forecast Uncertainty Bounds that are consistent across an ensemble of: (1) Generation & Load Forecast Models, (2) Weather Forecast Providers/Models, and (3) Weather Stations?

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Wish List

- Meter “True Load” in Real-time. Extend metering technology to measure:
  - Whole-house demand for electricity services,
  - Behind-the-meter Solar Generation, and
  - Behind-the-meter Storage.
    - Provide all pieces to System Operators in real time

- Meter Key End-Uses in (Semi) Real-time
  - EV Charging and other big ticket electricity uses, and
  - Demand response activity
    - Used to support research on customer behavior

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Wish List

- At the Minimum Meter Solar Irradiance in Real-time for a Fixed Mesh of Metering Points. Use these data to develop Real-time Estimates of Behind-the-Meter Solar Generation.
  - Supports Constructing True Load as Measured Load + Estimated BTM Solar Generation
  - Supports Real-time Calibration of BTM Solar Generation Forecasts

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Question #1. Missing Forecast Horizons

- One to 12 hours ahead Ramp Rate Forecasts @ Five Minute Level of Time Resolution
  - Requires BTM Solar Gen/Storage, EV Charging, etc. Ramp Rate Forecasts or Forecast Drivers

- Balance-of-the-Day out 12 Days Ahead Net Load Uncertainty Forecast Bounds
  - Anticipate requiring a statistical framework that combines the solar, wind, and load forecast uncertainty with respect to a common set of weather concepts and weather stations.

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Question #2. Biggest Challenges to Increasing Load Forecast Accuracy

- A lack of real-time metering of demand, BTM Solar Generation, BTM Storage, storage, etc.

- A lack of understanding how consumer behavior changes with the adoption of behind-the-meter generation/storage, EV charging, etc.

- A means to “backcast” load forecast models with observed weather and BTM Solar Generation. Right now it is impossible to decompose the load forecast error into model error, weather forecast error, and BTM Solar Generation forecast error. As a result it is difficult to determine what model changes need to be made.

- A consistent and accurate temperature, humidity, precipitation, and solar irradiance forecasts for forecast horizons of one hour ahead to 48 hours ahead across all weather stations.
  - The weather forecasts that drive the load forecast need to be consistent with the meteorological forecasts driving the BTM solar generation forecast; which in turn need to be consistent with the meteorological forecasts driving utility-connected solar and wind generation forecasts.

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Question #2. Biggest Challenges to Increasing Load Forecast Accuracy

- A lack of Load Forecast Modeling skill in the industry
  - The market does not place sufficient value on accurate Load Forecasts to justify the investment in time and money to develop a skilled load forecast modeler. This is unfortunate because the Load Forecast Modeling problem is only going to grow in complexity as the big ticket technologies penetrate the market place.

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Question #3. Research Opportunities for Higher Temporal Resolution and Time Horizons

- Improving BTM Solar Generation forecasts at the 5 minute level of temporal resolution for forecast horizons of up to two to four hours ahead

- Develop a statistically integrated framework for producing a Net Load Uncertainty Band forecast at the 5 minute level of temporal resolution for forecast horizons of up to 48 hours ahead

PERSPECTIVE ON LOAD FORECASTING RESEARCH NEEDS

Question #3. Research Opportunities for Higher Temporal Resolution and Time Horizons

- Develop a Dynamic Long-term (sub)hourly Net Load Forecast System that integrates:
  - Demand-Side Technology Growth trends
    - DER, EV Charging, TOU Price Impacts, EE and DR, and
  - Supply-Side Technology Growth Trends
    - Grid-connected Solar and Wind Generation.
  - Where the forecast engine utilizes historical weather patterns to construct Non-Parametric Net Load Forecast Uncertainty Distributions.
- The framework should be used to evaluate alternative mitigation strategies designed to minimize Net Load Forecast Uncertainty and the associated System Operating Costs
- The framework should mimic the dynamics of (sub)Hourly Grid Operations played out over a long-term planning horizon

THANK YOU

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